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Estimated Number of People Who Inject Drugs in the United States

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Background. Public health data signal increases in the number of people who inject drugs (PWID) in the United States during the past decade. An updated PWID population size estimate is critical for informing interventions and policies aiming to reduce injection-associated infections and overdose, as well as to provide a baseline for assessments of pandemic-related changes in injection drug use.

Methods. We used a modified multiplier approach to estimate the number of adults who injected drugs in the United States in 2018. We deduced the estimated number of nonfatal overdose events among PWID from 2 of our previously published estimates: the number of injection-involved overdose deaths and the meta-analyzed ratio of nonfatal to fatal overdose. The number of nonfatal overdose events was divided by prevalence of nonfatal overdose among current PWID for a population size estimate.

Results. There were an estimated 3 694 500 (95% confidence interval [CI], 1 872 700–7 273 300) PWID in the United States in 2018, representing 1.46% (95% CI, .74–2.87) of the adult population. The estimated prevalence of injection drug use was highest among males (2.1%; 95% CI, 1.1–4.2), non-Hispanic Whites (1.8%; 95% CI, .9–3.6), and adults aged 18–39 years (1.8%; 95% CI, .9–3.6).

Conclusions. Using transparent, replicable methods and largely publicly available data, we provide the first update to the number of people who inject drugs in the United States in nearly 10 years. Findings suggest the population size of PWID has substantially grown in the past decade and that prevention services for PWID should be proportionally increased.

Keywords. injection drug use; people who inject drugs; HIV; hepatitis C virus; drug overdose.

In the United States, injection drug use (IDU) has increased during the past decade alongside evolution of the opioid overdose crisis, in which substances used have shifted from primarily misuse of prescription opioids, to use of heroin, and most recently to use of stimulants and synthetic opioids [1–4]. Surveillance and other public health data signal increases in IDU. These signals include observed increases in human immunodeficiency virus (HIV) outbreaks [5–11] and acute hepatitis C virus (HCV) infections among people who inject drugs (PWID) [12, 13], as well as injection wound-related infections [14–20]. Fatal overdoses [1, 21] and treatment admissions associated with substances that are primarily injected (eg, heroin) have also increased during the past decade [22, 23]. The increase in overdose deaths observed during the COVID-19 pandemic suggest IDU may have further increased in the pandemic era [24]. However, the most recent estimate for the prevalence of IDU is from 2011 [25]. An updated estimate is needed to inform public health programs and policies for PWID and to serve as a baseline for understanding potential changes in IDU during the pandemic era.

Because of the stigmatized and criminalized nature of IDU, the measurement and monitoring of temporal trends in prevalence of this behavior is challenging. In the United States, self-reported data from population-level surveys are the primary source used for estimating number of PWID and IDU prevalence [17–19]. The major limitation of this approach is population-level surveys do not adequately represent people who are unstably housed or incarcerated, who are, on average, more likely to be PWID compared with the general population. Moreover, PWID who are sampled by these surveys may be less likely to participate or hesitant to self-report past-year IDU to data collectors [26]. The most recent estimate of the number of PWID is 774 434 (0.30% of US population aged 13+ years) in 2011 [25]. This estimate is based on population-level survey data and is likely a considerable underestimate.

A current, valid estimate of the US PWID population size that can be routinely updated is urgently needed. Rates of HCV and HIV infections and overdose mortality among

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PWID cannot be computed without an estimate of the number of PWID as the denominator. Rates expressed as a function of population size are key to understanding whether the observed increases in numbers of infectious disease cases and overdose events are due to riskier injection behaviors among PWID, are driven by increases in the number of PWID, or are caused by unmet needs for prevention services. Moreover, these rates are also needed to monitor progress toward federal and state HCV and HIV elimination goals as well as the federal overdose prevention strategy [27–29]. In the context of these strategies, a current PWID population size estimate can both inform resource allocation and program planning for intervention scale-up and help to monitor effectiveness of such programs through assessment of change in the risk-specific burden of these infectious diseases. In this manuscript, we present a novel multiplier approach to estimate the number of PWID in the United States.

METHODS

We used a multistep multiplier approach to estimate the number of adults who injected drugs in the United States in 2018 (Figure 1). Each step of the analysis is described in detail later; briefly, we used inputs from 2 of our previously described estimates—the estimated number of injection-involved overdose deaths [30] and the estimated ratio of nonfatal to fatal overdose among PWID [31]—to infer the number of nonfatal overdose events among PWID. We then divided the number of nonfatal overdose events by the percentage of PWID reporting overdose for a population size estimate. Analyses were limited to adults ≥18 years of age and were conducted within 64 strata defined by all combinations of US Census region (Midwest, Northeast, South, West), sex (male and female), age group (18–39 and ≥40 years), and race/ethnicity (Hispanic/Latinx, non-Hispanic black, non-Hispanic White, non-Hispanic other).

Step 1: Estimate Number of Fatal Drug Overdoses Among PWID

Using a recently described approach [30], we estimated the number of overdose deaths in 2018 for each demographic/geographic stratum that were specifically injection-involved (Table 1). Briefly, we used drug treatment admission data from the Treatment Episode Data Set-Admissions (TEDS-A) to estimate the percent of treatment admissions that reported injection across 5 drug types: heroin/synthetic opioids (excluding methadone), stimulants (including methamphetamine, other amphetamines, other stimulants), natural/semisynthetic opioids/methadone, cocaine (including crack), and sedatives (including benzodiazepines, other tranquilizers, barbiturates, other sedatives) [32]. Data from the National Vital Statistics System (NVSS) on the annual number of overdose deaths were obtained through a data request to the Centers for Disease Control and Prevention (CDC) National Center for Health Statistics (NCHS) [33]. All deaths that listed an International Classification of Diseases, 10th edition, code for drug overdose (X40-X44, X60-X64, X85, Y10-Y14) were classified into 5 mutually exclusive drug type categories based on the following specific multiple-cause-of-death codes: heroin/synthetic opioids other than methadone (T40.1, T40.4), natural or semisynthetic opioids and methadone (T40.2, T40.3), cocaine (T40.5), psychostimulants with abuse potential (T43.6), sedatives (T42.3, T42.4), and other (T36-T59.0) [21, 34]. Deaths that indicated multiple drug types were categorized based on the drug with the highest probability of injection as estimated from the TEDS-A treatment data, and overdose deaths without a specific T-code listed (ie, only listed T50.9) were distributed to the 6 categories based on the nonmissing distribution within each demographic strata [35, 36]. We multiplied the drug-specific probabilities of injection from TEDS-A data by the respective number of overdose deaths and collapsed across drug type, resulting in the estimated number of injection-involved overdose deaths for each demographic stratum.

Steps 2 and 3: Estimate the Number of Nonfatal Overdose Events Among PWID

To infer the estimated number of nonfatal overdose events from the number of injection-involved overdose deaths, we estimated the ratio of nonfatal to fatal overdose among PWID using our previously meta-analyzed fatal and nonfatal overdose rates (step 2) [31]. This meta-analysis synthesized peer-reviewed studies on overdose among PWID in Organisation for Economic Co-operation and Development (OECD) countries with data collected from 2010 to 2020. We used the estimated nonfatal overdose rate of 24.7 per 100 person-years (95% confidence interval [CI], 19.9–30.8) and the fatal overdose rate of 0.6 per 100 person-years (95% CI, .3–1.2) among PWID to calculate the nonfatal to fatal overdose ratio of 40.8 (95% CI, 20.7–80.6). We multiplied this ratio by the number of injection-involved overdose deaths from step 1 to estimate the number of nonfatal overdose events within each stratum for 2018 (step 3).

Step 4: Estimate the Number of PWID

Through a CDC data request, we obtained data from the 2018 National HIV Behavioral Surveillance System (NHBS) Injection Drug Use cycle, which uses respondent-driven sampling to collect data on PWID in 23 US metropolitan statistical areas [37]. Eligible persons were 18 years of age or older, lived in a metropolitan statistical area where interviews are conducted, and reported injecting drugs in the 12 months before the interview. Among NHBS participants that reported opioid use, we estimated the proportion of respondents with at least 1 nonfatal overdose in the past year across 16 strata defined by age, sex, and race/ethnicity. We divided the number of nonfatal

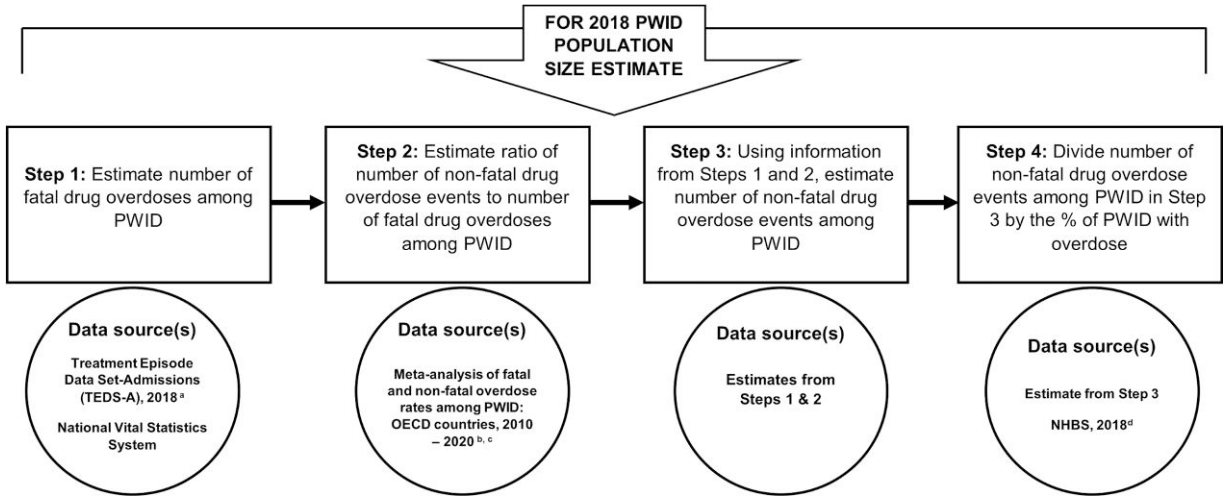

Figure 1. Data steps and sources for estimating the number of adult persons who inject drugs (PWID), United States, 2018.

overdose events by the proportion of PWID that reported a nonfatal overdose in the past year to estimate the number of PWID within each stratum. We collapsed across strata to estimate the number of PWID overall and by each single stratification. Using population denominators from the 2018 NCHS Bridged-Race Population Estimates, we estimated the percent of adults 18+ years of age that injected drugs in 2018 overall and by demographic groups [38].

Table 1. Estimated Number of Injection-involved Overdose Deaths Among Adults, United States, 2018 (Step 1)

	Overdose Deaths	Injection-involved Deaths (95% CI)	Row % (95% CI)
Overall	67 021	28 257 (28 192–28 322)	42.2 (42.1–42.3)
US Census Region			
Midwest	15 060	6758 (6722–6795)	44.9 (44.6–45.1)
Northeast	15 539	7615 (7589–7641)	49.0 (48.8–49.2)
South	24 175	9964 (9924–10 004)	41.2 (41.1–41.4)
West	12 247	3919 (3898–3940)	32.0 (31.8–32.2)
Sex			
Female	22 270	8030 (7996–8063)	36.1 (35.9–36.2)
Male	44 751	20 227 (20 172–20 284)	45.2 (45.1–45.3)
Race/ethnicity			
Hispanic	6274	2565 (2548–2581)	40.9 (40.6–41.1)
Non-Hispanic Black	9213	1609 (1591–1628)	17.5 (17.3–17.7)
Non-Hispanic Other	1500	479 (473–485)	31.9 (31.5–32.3)
Non-Hispanic White	50 034	23 604 (23 545–23 664)	47.2 (47.1–47.3)
Age, y			
18–39	29 317	15 934 (15 899–15 970)	54.4 (54.2–54.5)
40+	37 704	12 322 (12 269–12 377)	32.7 (32.5–32.8)

Note: 95% CI is estimated using 10 000 bootstrap iterations.

Abbreviation: CI, confidence interval.

Quantifying Uncertainty

We estimated CIs that account for the joint statistical uncertainty of each step of the approach. This was done using a Monte Carlo simulation that defined distributions and resampled estimates from all inputs with statistical uncertainty and recomputed all analytic steps. We resampled inputs (k = 10 000 runs) for the percentage of treatment admissions with injection (step 1), the meta-analytic rates of nonfatal and fatal overdose among PWID (step 2), and the percentage of people who injected opioids with an overdose in the past year (step 4). The median defined our point estimates and the 2.5th and 97.5th percentile of the resulting distributions constitute the 95% confidence intervals.

RESULTS

Previously reported estimates of injection-involved overdose deaths by demographic/geographic group are presented as step 1 interim results (Table 1) [30]. Of the 28 257 (95% CI, 28 192–28 322) injection-involved overdose deaths in 2018, the majority occurred among male persons (n = 20 227; 95% CI, 20 172–20 284), non-Hispanic White persons (n = 23 604; 95% CI, 23 545–23 664), and adults 18–39 years of age (n = 15 934; 95% CI, 15 899–15 970). We estimated there were 1 153 600 (95% CI, 586 000–2 277 700) nonfatal overdose events in 2018 (Table 2). Most nonfatal overdose events occurred among males, non-Hispanic Whites, and adults 18–39 years of age.

We estimated there were 3 694 500 (95% CI, 1 872 700–7 273 300) PWID in the United States in 2018, translating to an estimated IDU prevalence of 1.46% (95% CI, .74–2.87) among adults (Table 2). Based on these results, we estimate that for every nonfatal overdose event, there were, on average, 3.2 PWID (3 694 500/1 153 600). Although the South had the highest

Table 2. Estimated Number of Nonfatal Overdose Events (Step 3) and Population Size (Step 4) Among Adult Persons who Inject Drugs (PWID), United States, 2018

		Nonfatal Overdose Events			PWID Population Size					
	US Adult Population	Median	95% CI		Median	95% CI		IDU %	95% CI	
Overall	253 768 092	1 153 600	585 900	2 277 700	3 694 500	1 872 700	7 273 300	1.46	.74	2.87
US Census Region										
Midwest	44 508 612	230 900	117 200	456 400	770 500	389 700	1 526 800	1.73	.88	3.43
Northeast	52 859 934	311 200	158 000	613 500	973 500	494 500	1 922 600	1.84	.94	3.64
South	96 242 605	303 000	153 700	598 000	985 300	499 200	1 947 100	1.02	.52	2.02
West	60 156 941	308 500	156 800	609 100	964 600	489 100	1 901 800	1.60	.81	3.16
Sex										
Female	130 130 262	327 900	166 400	646 300	1 097 600	555 000	2 163 400	0.84	.43	1.66
Male	123 637 830	826 000	419 100	1,631,300	2 594 000	1 316 700	5 129 400	2.10	1.06	4.15
Race/ethnicity										
Hispanic	41 170 562	104 700	53 100	206 500	381 600	193 100	753 200	0.93	.47	1.83
Non-Hispanic Black	31 815 859	65 700	33 400	129 600	291 400	147 600	576 400	0.92	.46	1.81
Non-Hispanic other	18 230 187	19 500	10 000	38 500	58 500	29 500	115 800	0.32	.16	.63
Non-Hispanic White	162 551 484	963 700	489 800	1 902 800	2 961 900	1 501 600	5 835 000	1.82	.92	3.59
Age, y										
18-39	101 749 577	650 600	330 400	1 284 900	1 855 300	939 200	3 657 800	1.82	.92	3.59
40+	152 018 515	503 200	255 500	993 200	1 837 500	928 900	3 628 700	1.21	.61	2.39

Abbreviation: CI, confidence interval.

number of PWID (n = 985 300), it had the lowest IDU prevalence (1.02%; 95% CI, .52%–2.02%) compared with the other regions. More than 70% of PWID were male (n = 2 594 000; 95% CI, 1 316 700–5 129 400) and 80% were non-Hispanic Whites (n = 2 961 900; 95% CI, 1 501 600–5 835 000). The estimated IDU prevalence among non-Hispanic White adults (1.82%; 95% CI, .92%–3.59%) was nearly double the prevalence among Hispanics adults (0.93%; 95% CI, .47%–1.83%) and non-Hispanic Black adults (0.92%; 95% CI, .46%–1.81%). Half of PWID were aged 18–39 years of age (n = 1 855 300, 50.2% of total PWID), whereas that age group constitutes only 40% of the adult population.

DISCUSSION

We estimated nearly 3.7 million people, or 1.5% of the US adult population, injected drugs in 2018. This estimate is more than 5 times the most recent US estimate of ~774 000 from 2011 [25]. Much of this increase is likely attributable to increases in IDU, but it is important to consider methodological differences in the creation of this 2018 estimate vs the 2011 estimate. The 2011 estimate was based on self-reported IDU among respondents to household surveys [26], but the present estimate combines available data on substance-specific overdose deaths and treatment admissions with cohort and cross-sectional data collected from known PWID. Applying the same data sources and analytic methods used for the 2018 estimate to 2011 yields an estimated 1.3 million PWID in 2011, which suggest the 2018 estimate is closer to 3 times higher than in 2011. By any measure, these estimates suggest the number of PWID has increased substantially in the U.S. during the past decade.

One of the primary contributions of this estimate is the transparent, replicable nature of the methods described. Overdose data specifically among PWID in the United States continue to be relatively sparse, both in research and surveillance data. We used the best data currently available for each input, which are subject to limitations in some cases given data sparsity. For example, we used the meta-analyzed ratio of fatal to nonfatal overdose among PWID in OECD countries rather than a ratio specific to the United States, which was unattainable given currently available data. The uncertainty associated with this meta-analyzed ratio is reflected in confidence intervals around estimates presented here. Our intention is that, as surveillance systems implemented in the United States in recent years mature [39], resulting data can be used to refine and update this PWID population size estimate.

Notwithstanding data input limitations, this updated estimate provides a data point for monitoring the US PWID population size over time and can inform strategies to reduce transmission of infectious diseases. In recent years, political will has been building to eliminate HCV and HIV infections in the United States [27, 28]. Both bloodborne infections disproportionately affect PWID but are highly preventable using evidence-based interventions, such as provision of sterile syringes through syringe services programs and substance use treatment [40–43], as well as treatment of prevalent infections with antiretroviral therapy [44] and direct-acting antivirals [45]. Increases in IDU prevalence will threaten the success of elimination strategies for HCV and HIV infections in the

absence of concomitant increases in availability of harm reduction services and treatment for both infectious diseases and substance use. These services will need to be substantially scaled up nationally to meet the needs of nearly 4 million people [46].

In addition to the high burden of infectious diseases, PWID experience preventable mortality and morbidity due to drug overdose. Overall, the rate of overdose deaths increased from approximately 6 per 100 000 persons to 22 per 100 000 persons during 1999–2019 [21], and provisional data indicate the number of overdose deaths increased by another 31% during just 1 year of the pandemic era from March 2020 to March 2021 [24]. During the pandemic era in particular, many questions remain about the extent to which increased overdose mortality rates are attributable to injection initiation vs changes in injection behaviors or the drug supply as well as to disruptions in access to treatment and recovery support services and harm reduction services. These estimates provide a prepandemic baseline and can improve our understanding of potential increases vs changes in pandemic-era injection behavior.

In this estimation of the number of people who inject drugs in the United States, we assumed an equal ratio of nonfatal to fatal overdose rates across demographic groups because of a lack of data to suggest otherwise. However, variation in our stratified results reflect patterns recently observed in analysis of health conditions that signal IDU. For example, we estimate the percentage of adults aged 18–39 years who inject drugs is 1.5 times higher than among older adults, which aligns with reported incidence rates of acute HCV infection, which, in 2018, were highest among adults aged 20–39 years [12]. Additionally, we report the South as the region with the largest number of persons who injected drugs in 2018. An analysis of mortality rates associated with HCV infection from 2017 found that counties with the highest death rates among adults <40 years of age are disproportionally located in the South [30]. Similarly, the high burden of hospitalizations for bacterial infections related to IDU among non-Hispanic Whites aligns with our estimate of an elevated IDU prevalence among adults in this group [20]. Despite general alignment with external data, these stratified estimates should be interpreted with more caution than the overall population size estimates.

Study limitations include several potential biases associated with data inputs to these estimates as summarized in Table 3. First, we estimated injection-involved overdose deaths by applying the probability of injecting each substance among people entering treatment to deaths involving that substance, which assumes the probability of injecting a particular substance is the same among people entering treatment and decedents. If decedents were more likely to inject a substance than people entering treatment, which is the most likely scenario, the PWID population size will be underestimated. Second, we used a ratio of nonfatal to fatal overdose rates from OECD countries, in which overdose patterns may differ from those in the United States, pooled from 2010 to 2020 studies. To produce a nonfatal overdose rate, nonfatal overdose prevalence during a survey recall period was in some cases converted to a rate with person time computed by the recall period. Participants in some cross-sectional studies were asked about experiencing "any overdose" during the recall period, so overdose events may have been underestimated for people experiencing multiple overdose events during the recall period. Additionally, because of data sparsity, a US-specific ratio was not available, nor was a ratio specific to time or characteristics of PWID from the meta-analysis. However, published rates from the same meta-analysis indicate the US nonfatal overdose rate was 28.6/100 during this period compared with 24.7/100 in all OECD countries. These estimates are not substantively different and have overlapping CIs [31]. More research and surveillance efforts are needed to produce nonfatal and fatal overdose rates specific to PWID by characteristics of person, time, and place. Finally, the NHBS estimate of overdose in the past year that we used to convert the number of nonfatal overdose events to PWID population size was limited to people in urban areas who injected opioids. If rural PWID are more likely than urban PWID to experience nonfatal overdose

Table 3. Expected Direction of Bias for Key Assumptions in the Estimation of the Population Size of Persons who Inject Drugs, United States, 2018

Possible Assumption Violation	Direction of Bias in PWID Population Size Estimate
Probability of injection is higher per drug type among decedents compared with people entering treatment	Underestimate
Nonfatal overdose rate used for ratio is higher because conversion from percentage to ratio included 1 overdose per survey recall period for cross-sectional studies in which participants were asked about experiencing "any overdose" during the recall period	Underestimate
Ratio of nonfatal to fatal overdose is lower among Black PWID compared with PWID of other race/ethnicities	Underestimate
Ratio of nonfatal to fatal overdose is lower in South compared with other regions	Overestimate
Ratio of nonfatal to fatal overdose is lower in Northeast compared with other regions	Overestimate
Percentage of PWID reporting overdose in past 12 months in NHBS is lower if people using drugs apart from opioids were asked overdose question	Overestimate
Percentage of PWID reporting overdose in past 12 months in NHBS is higher if rural PWID included in NHBS	Underestimate

Abbreviations: NHBS, National HIV Behavioral Surveillance; PWID, people who inject drugs.

[a]Stratified by sex, age, race/ethnicity, region.

[b]Shealey et al. [31].

[c]No stratifications available.

[d]% PWID reporting overdose in past year stratified by sex, age, and race/ethnicity.

during the course of the year, for example, this percentage will be underestimated and our population size would be overestimated.

Despite these limitations, our method offers an approach to provide more robust and routine estimation of PWID population size as additional and improved data become available. Improvements in surveillance of injection-involved overdose deaths will enhance use of this method. NVSS death records do not currently include route of administration for overdose deaths, but improvements in death scene investigations being implemented through CDC's State Unintentional Drug Overdose Reporting System will lead to better estimation of the number of injection-involved overdose deaths [39]. Additionally, many of the data sources used for inputs (eg, NVSS mortality data, TEDS-A data) can be stratified by PWID characteristics and substance type, but the ratio of nonfatal to fatal overdose across different substances could not be varied based on existing data. Developing a better understanding of how this ratio may differ by both PWID characteristics and substance types used would facilitate more robust stratified estimates.

In conclusion, the modified multiplier method described here uses transparent methods and largely publicly available data to update the number of PWID, and associated IDU prevalence, in the United States. This is an estimate that has not been updated or improved on in nearly 10 years. Despite potential biases associated with data inputs, this is a useful metric for understanding how IDU prevalence has changed alongside shifts in the opioid overdose crisis from primarily misuse of prescription opioids to use of heroin and synthetic opioids. This estimate can be routinely updated for further monitoring of population-level IDU behavioral risks. This updated estimate suggests harm reduction and other services for PWID need to be substantially expanded for the United States to reach HCV and HIV infection elimination targets and to reduce escalating rates of overdose mortality.

Notes

Disclaimer. The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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Potential conflicts of interest. K. B. reports salary as an employee at the US Centers for Disease Control and Prevention. E. H. reports consulting fees from Merck & Co. for work unrelated to this paper. All other authors report no potential conflicts.

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